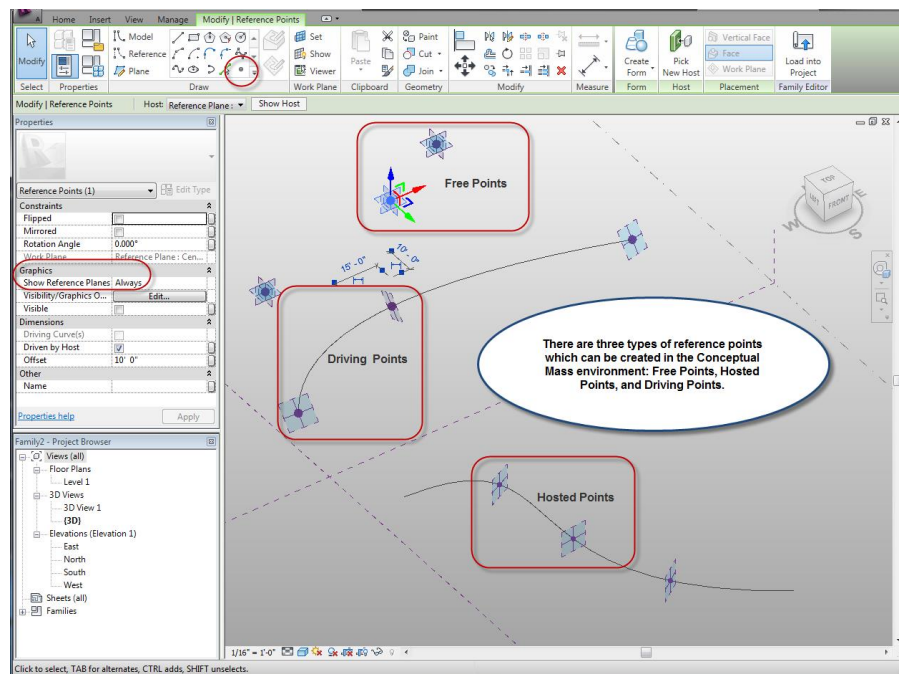


AGENDA:

1. Reference Points –Free Points, Hosted Points and Driving Points
2. Adaptive points and Stitched Border Families
3. Adaptive Components

1. Reference Points

Reference points are used to define a specific location in the XYZ coordinate system of the conceptual design environment. Reference points allow you to create a framework of locations which can be used to define the path for one or more lines, splines, or forms. There are three types of Reference Points: Free Points, Hosted Points, and Driving Points.

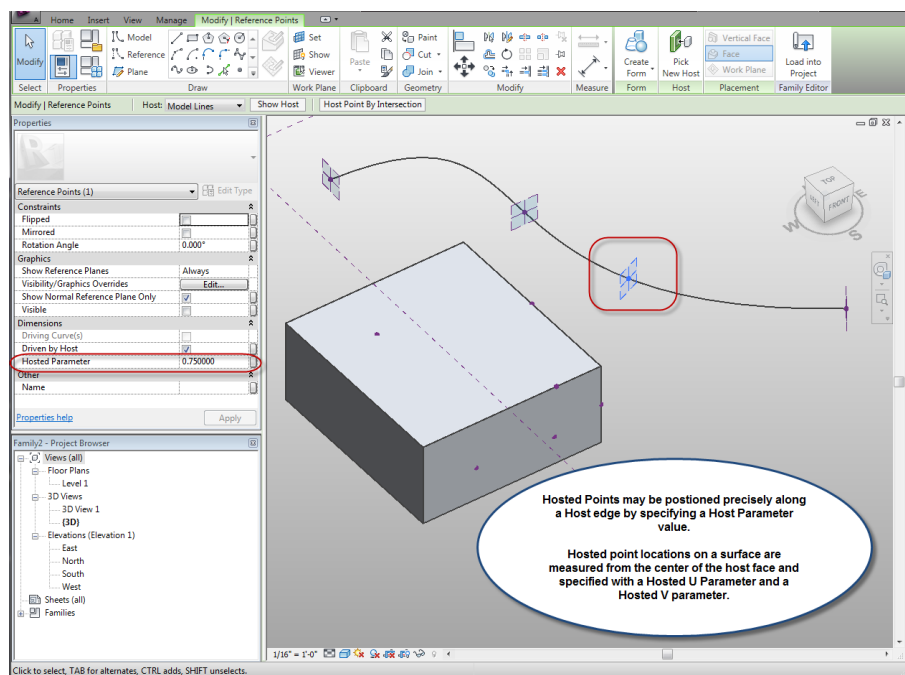


Free Points are placed on a reference plane and are usually associated with that reference plane so if the reference plane is moved, the points will move as well. They may be offset a specified distance from the reference plane and rotated about their own Z axis. They display a set of 3D controls when selected and may be moved to any position in space. When other objects are created on a Free Point's reference planes, they will be linked to the position and orientation of the Free Point.

Free points define three reference planes with their origin located on the point. By default, Free points do not display their reference planes even when they are selected. As with all reference points, they have a “Show Reference Planes” property which can be set to Never, When Selected, or Always.

Hosted Points are reference points which are placed on an existing line, arc, spline, edge, or surface. Hosted points appear smaller than Free Points or Driving point and they define an additional “Normal” reference plane which allows you to create geometry which is perpendicular to the host.

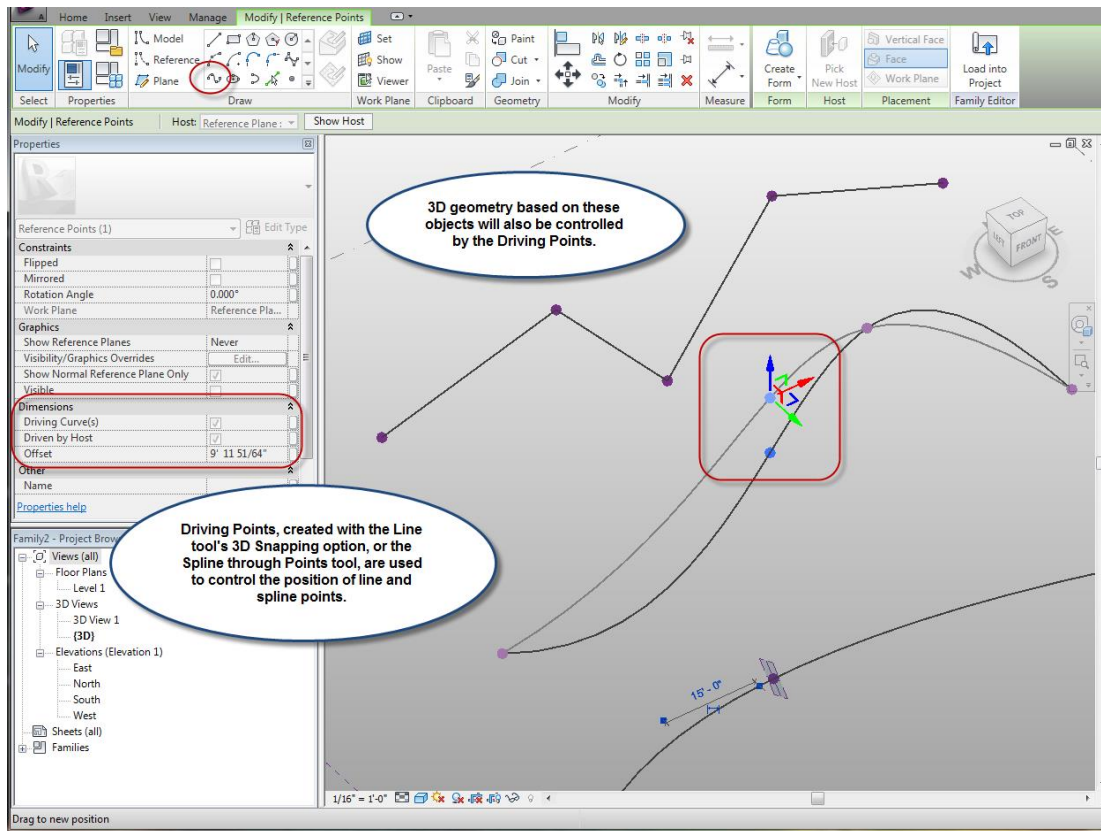
Hosted points will move with their host but they may also be repositioned along a host edge or within the host surface. If a hosted point is placed on an edge or a spline, it will use a property called Hosted Parameter which may be set in a range of 0.00 to 1.00 with these values placing the point at either the start point or endpoint of the edge. A value of .75 would position the point at 75% of the distance between start and end points.



When hosted points are placed on a planar surface, they can be positioned with a Hosted U Parameter and a Hosted V parameter. Setting both values to 0 will place the point at the center of the face. The upper values will be bounded by the distance from the center to the edges.

By default, Hosted points and Driving points will only display the Normal reference plane but they both also define the typical set of three reference planes found on a Free point. To display these reference planes on Hosted or Driving points, disable their “Show Normal Reference Plane only

Driving Points are reference points which control the position of endpoints and control points on lines, arcs, and splines. Driving points are created for straight line segments by starting the Line tool and enabling the 3D snapping option on the Options bar. To create a curved spline controlled by driving points, create Free Points, select them and pick the Spline through Points tool on the Draw panel.



After creating the set of line segments or spline curve, pick the Driving points to display their 3D position controls. Driving points can display global coordinates (red, green, blue) and local coordinates (orange) depending on their shape.

The Offset value in the properties palette lets you specify the distance a point will be located above or below its host. This value can be parameterized with type or instance length parameters.

When you create 3D geometry such as Sweeps or Blends along a path controlled by Driving Points, those points will also control the resulting 3D forms. The points can be accessed in X-Ray mode to modify the 3D form dynamically or parameters may be used to reposition the points.

2. Adaptive Points and Stitched Border Families

An Adaptive point is a special type of modified Reference point which is only available in the Curtain Panel by Pattern template and the Adaptive Component template for Conceptual Masses. Adaptive Points may only be created in the Adaptive Component family.

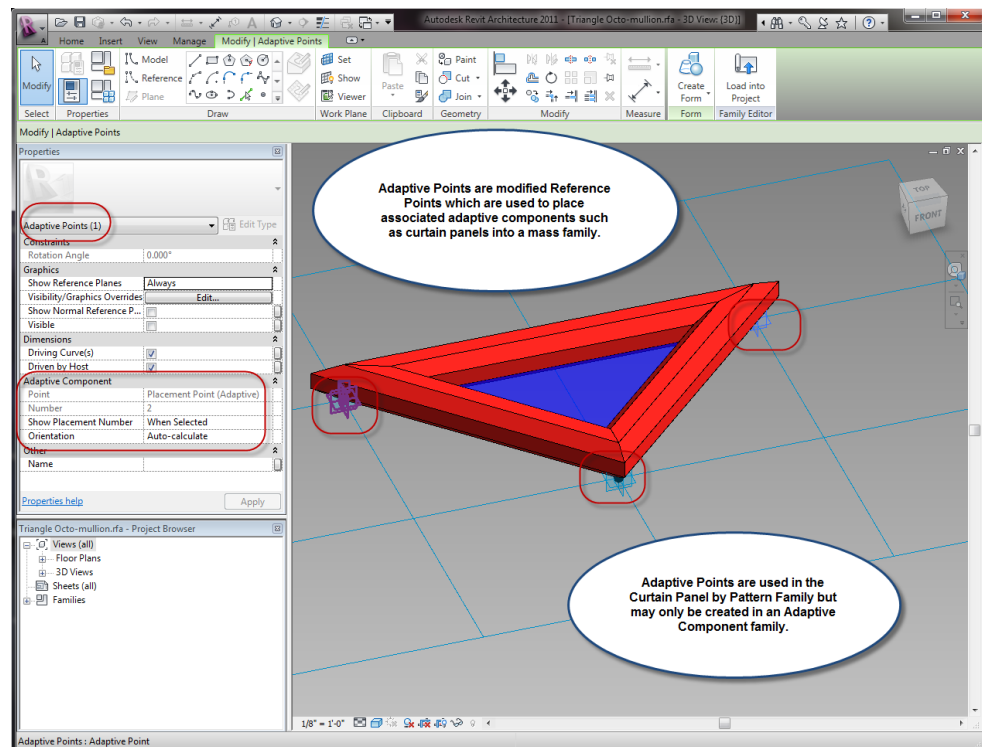
The number of adaptive points available in the Curtain Panel by Pattern family is controlled by the active Tile Pattern Grid and ranges from 3 in the Triangle Tile Grid to 8 in the Octagon Tile Grid.

Adaptive points can be defined as either

Placement Points or Shape Handle Points. An adaptive point which is set as a Placement point will be numbered in the order it will be placed when the adaptive component is added to a conceptual mass family. In the Curtain panel by pattern family, all of the predefined Adaptive points are placement points and this property may not be modified. You can choose how you wish to Show the Placement number on the point.

A shape handle point is not used during placement but will be available after placement to modify the shape of the associated geometry with 3D control handle moves.

Adaptive points have an Orientation property which can be specified to control the vertical orientation of an adaptive point. The default is Auto-Calculate which will try to generate the optimal direction to ensure closed loop geometry. Other options include Orthogonal, Vertical, or by Host Reference



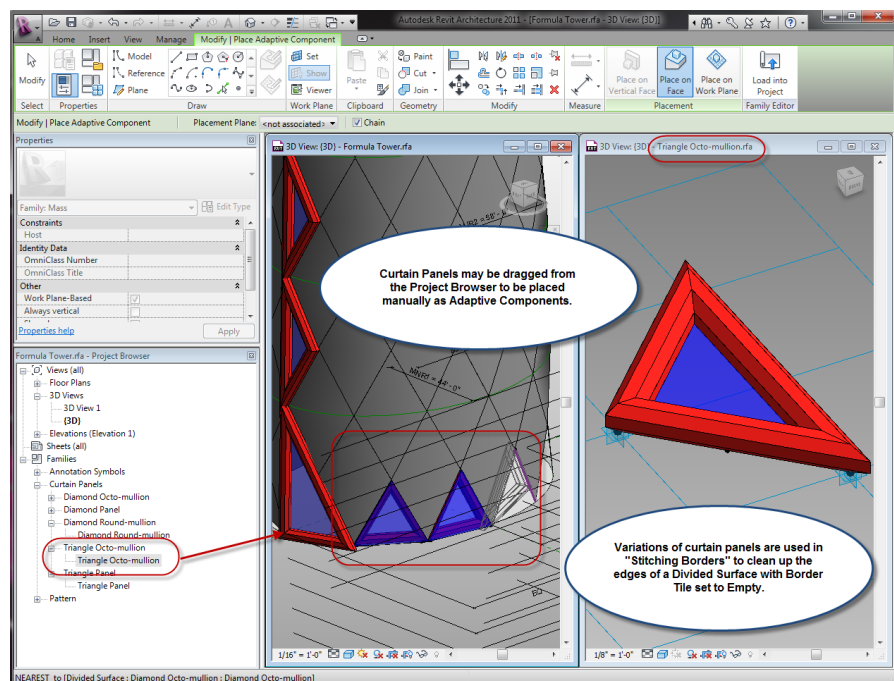
It is possible to manually “Stitch” surface border surfaces with Curtain Panel pattern components by dragging the panel types directly from the Project Browser into the drawing area. A Place Adaptive Component tab will appear on the ribbon with options to place the panel on a face or on a work plane.

Panel components are usually added to a divided surface or surface pattern but they can also be drawn on any other face geometry or on any work plane defined by a level or reference plane.

When you divide a fairly uniform shape with a rectangular pattern, it usually cleans up quite well at the edges. When you use more complex patterns such as Rhomboid or Hexagon, or if you rotate the axes of a rectangular division, it can be difficult to get a nice smooth set of border tiles. If you set the Border Tile to empty, regular holes will be created along the edges. These holes can be filled by manually adding a variation of the surface’s main curtain panel.

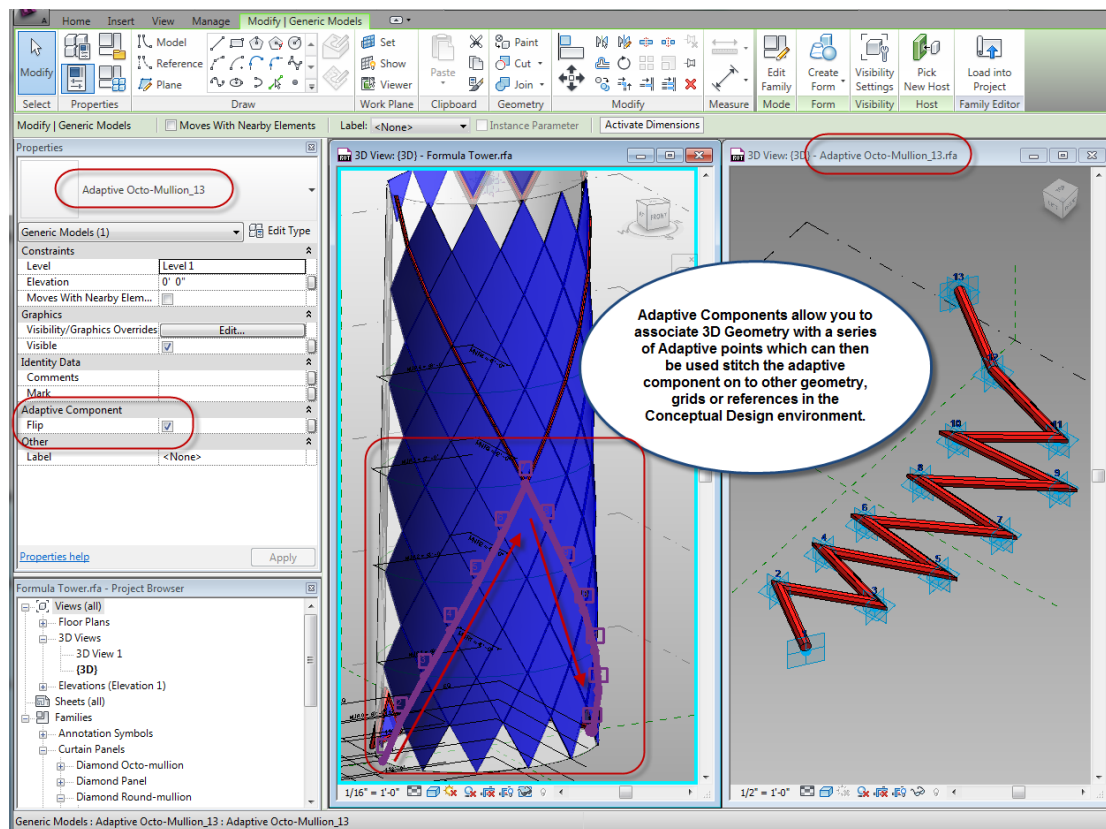
The edge variation will require a different tile grid with fewer vertices than the main panel. If the main pattern is Rectangular or Rhomboid, create a triangle variation. If the main pattern is Hexagon, use a Rectangular variation. Load the variation into the mass family and then drag and drop it from the Project Browser into the drawing area.

Turn off the display of the main components when stitching panels around edges and display only the surface or the pattern. This will provide a framework on to which you can pick the placement points for the panel. Picking points in a Clockwise or Counterclockwise direction will reverse the vertical orientation of the panel. If they go on backwards, pick them and use the Flip control in the Properties palette to reorient them.



3. Adaptive Components

Adaptive components are special families designed to take advantage of the Adaptive point functionality first developed for the Curtain Panel by Pattern family. This functionality allows you to associate 3D component geometry with a series of flexible placement points which can be placed into a conceptual mass.



Adaptive points may only be created in a special type of family started with the **Generic Adaptive Component** template. Adaptive points are created by modifying Free or Driving reference points.

To make an adaptive point, select one or more reference points and pick the Make Points Adaptive tool on the ribbon or change their point type property in the Adaptive component section of the Properties palette. This property may be set to Placement Point or Shape Handle Point. There is also a Reference Point option which will disable the adaptive functionality of the point. Adaptive functionality can also be toggled with the Make Adaptive tool on the Ribbon.

Adaptive components may not be loaded directly into the Project environment, but they can be placed in either conceptual mass families or into the In-Place Mass environment inside a project.

To associate a set of line segments with adaptive points, draw the lines with 3D Snapping enabled to first create a set of driving points associated with the line segments. Select all of the driving points and make them adaptive.

To associate a smooth spline with adaptive points, draw reference points, select them and choose the Spline through points tool. This will convert the free points to Driving points and associate them with the spline. Next, select all of the driving points and change them to Adaptive.

When you create adaptive points from driving points along a spline or series of line segments, they will be numbered sequentially from the start point to the end point. When you make Free points Adaptive, occasionally you will need to renumber them to place them in a logical sequence. To renumber an adaptive point, you can set the number value in the properties palette or just pick a point and then pick on the number displayed above the point to change it directly in the view.

When you place an adaptive component specify all of the placement points and then you can continue to place multiple instances until you cancel the command. There is also a Chain option on the options bar which will automatically place point 1 of the second instance of the component coincident with the final point of the previous instance.

When you use the Chain option for adaptive components which are defined with a closed perimeter, it ensures that sequential panels are aligned.

If you place a linear sweep as an adaptive component, the joints between instances of components will not miter smoothly with each other. An alternative is to count how many points are required in the sequence and create an adaptive linear component with a matching number of points. A single adaptive sweep with 12 points will generate a much smoother result than 6 instances of a 2 point sweep placed end to end with the Chain option.

Exercise Notes

- In the following exercise you will learn how to place Pattern Component instances as adaptive components and also how to create and place custom Adaptive components.
1. Start Revit and open the Formula Tower mass family you created in lesson 9. Set the parameters for the tower to remove the twist angle, set the PPH to 50 feet. The two CPL values to -1', and the Base major radius to 60 feet with the minor radius at 45 feet.
 2. If you have already divided the surface or applied components we are going to modify them. Delete the existing divided surfaces. Pick one of the surfaces, divide it and apply the Rhomboid pattern. Leave the layout settings at their default of Number with 12 divisions in each direction. This will create diamond shaped cells about 25 feet high by 12 feet wide.
 3. Create a new family with the Curtain Panel by Pattern template. Set the tile grid to Rhomboid and increase the horizontal and vertical distances to 12 feet to get the grid close to the sizes of the starting surface divisions in the Formula Tower family.
 4. Add a reference point at the midpoint of any of the four perimeter reference lines. Pick the reference point and then start the polygon tool. Create an 8 sided polygon, centered on the reference point, with a radius of 2'-0". Pick the polygon and the four reference lines and then choose Create Form. Save the file as Rhomboid_Octo_Mullion and then pick Load into Project. Select the Divided Surface and apply the new component family. If you are prompted to "Delete types", pick Ok.
 5. Zoom in to the top or bottom of the tower and you can see how some of the pattern components have been cut off and some are extending beyond the extents of the surface. This is because the profile was extending outside the extents of the rhomboid perimeter. Pick the surface pattern and set the type back to the 2D Rhomboid pattern. Tile your viewports and switch back into the pattern component family.
 6. Edit the profile for the sweep and move the profile over and up 2 feet in each direction. This will place the profile above the grid and inside the perimeter. Finish the edit, save the file, and Load it into the Tower again. Overwrite the existing version and apply it to the surface.

7. This time the pattern applies without deleting any instances and it cleans up better at the top and bottom edges. If you zoom in closely, you can see that there are small gaps between the instances of the pattern. This is due to the curvature of the surface.
8. Switch back to the component family. Edit the profile and move the shape out so that the endpoints of the horizontal segments touch the vertical reference plane. Load the family into the project again and overwrite the existing version. This time the gaps are eliminated, and only a V-shaped groove appears between each instance. At the top and bottom of the surface, the points of the diamonds are again overhanging the edges.
9. Switch to a front view. Select the surface and set the Border tile to Empty. Set the U-Grid to Distance and set the value to 24'-0". This leaves a gap at both the top and bottom. Adjust the distance until the points on the diamonds are as close as possible to the extents of the surface. 24'-6" to 24'-7" seems to be the closest values.
10. Switch back to the component family. Add a material parameter to the mullion component. Create a Panel Material parameter as well. Hide the Mullions and create a panel from the perimeter reference lines. Select the extrusion in the properties palette, set its positive offset to 1'-0" and its negative offset to - 9". This will raise the panel away from the curved surface. Open the Family types dialog and assign materials to the Mullion and Panel material parameters. Reset the temporary Hide elements and Load the family back into the project.
11. Ooooh, pretty. ☺ Now. What to do about those empty sections at the borders. Pick the surface and on the Surface Representation panel, disable Component and enable Pattern. This will allow us to snap to the endpoints of the underlying pattern while avoiding the complex geometry of the mullions.
12. Switch back to the component family. Add visibility parameters to both the Panel and the Mullions. Open the Family Types dialog and create three Types called Panels_Only, Mullions_Only, and Panels-Mullions. Adjust the visibility parameters as appropriate.
13. Save the family and then use the Save As command to create a new family called Triangle-Octo-Mullion. Pick the tile grid and change it to Triangle Flat. Delete the existing panel and mullions.

14. Create a new panel and sweep using the same sizes, offsets, and positions as the Rhomboid family. Assign material parameters and visibility parameters and take a look at the Family Types dialog to confirm that we already have three types defined. Pick Load into Project.
15. In the Formula Tower file, expand the curtain panels category under the Families listing and find the Triangle_Octo_Mullion family. Pick the Panels-Mullions family type and drag it into the viewport. Select the Chain option on the Options bar and zoom in to the points at the top of the pattern. Start picking points in a logical sequence to “Stitch” the triangular panels into the empty areas along the borders of the main pattern. The larger triangles in the corners are a bit trickier but do your best to keep the top edge horizontal. If the panels are flipped so the components are buried in the surface instead of pointing outwards, you can either use the Flip option in the properties palette to reverse them, or you can try adding them again and reverse the direction you are using to pick the points.
16. Repeat the border stitching process on all four edges of the surface. When you stop and then restart, use the temporary Hide tools to get the 3D panels out of your way and facilitate the selection process. Alternatively you can use the Point snaps to ensure you are aligned with the actual pattern. Reset the temporary visibility and enable the surface component display to see how it all fits together.
17. Select the main surface and in the Type Selector, switch to the Panels Only type. This removes the overlapping points at the top and bottom but leaves a gap where we reduced the height of the pattern. Change the layout type for the U Grid back to Number and the pattern will shift to the upper and lower extents of the tower.
18. Turn off the surface representation at all levels and then change your view to the other side of the tower. Divide the surface and assign the Rhomboid Octo-Mullion family, Panels Only type. To Add a border along the top and bottom, we are going to create an Adaptive Component family. First, disable the component representation and show the Pattern.
19. Create a New Family and choose the Generic Adaptive Component template. From the draw panel, pick Reference and enable the 3D Snapping option. Draw a single line segment. Pick the two reference points and from the Ribbon, choose Make Adaptive.

20. Select the number 1 adaptive point and in the properties palette, choose the option to show Normal Reference plane only. Pick the point and add an 8-sided polygon. Position it with the midpoint of the lower horizontal line at the the origin. Use Create Form to sweep the polygon along the reference line.
21. Add a material parameter to the Mullion and assign the same material you used in the main panel family. Choose Load into Project. We are going to use the adaptive mullion component to create an X-shape across the entire surface. The component should appear attached to your cursor. Zoom in to the top of the tower, make sure the Chain option is enabled and start stitching the component along a diagonal pattern line of the surface from point to point. After 2 or 3 segments stop and take a look at the connections between the mullion segments. Even with the Chain option enabled, the segments do not appear continuous.
22. Delete the segments you just added and then switch back to the Adaptive component family. Delete the existing component and then use the Save As command to create a new file called Adaptive Octo Mullion 13pt. Sketch a reference line with 3D snapping enabled and choose 13 points to create a 12 segment path. Load this new family into the tower and try adding a 12 segment diagonal from the lower left corner of the surface to the upper right corner of the surface. As we progress past the halfway point on the diagonal, the component reverses. Delete the first attempt.
23. Drag the component back into the viewport again and create an inverted V shape. Start at the lower left corner, go up on the diagonal until point 7, and then change the direction and go back down to the lower right corner. This method should place them entire sequence without having it reverse direction.
24. Add a second V-shaped section from the Upper left corner, down on the diagonal to the middle of the surface and then back up on the diagonal to the upper right corner.
25. Continue to add triangle panels and/or more adaptive components to fine-tune the design. Be creative and have fun with it. The point is to practice the panel by pattern and adaptive component placement methods. 😊